RA1779

Programmable synthesized communications receiver

Frequency range 15 kHz — 30 MHz
Non-volatile EAROM channel memory with 31 programmable channels
General purpose receiver with Surveillance,
Channel Scanning and Band Occupancy applications
External control facilities
Three speed electronically selected tuning rate
For use by Defence Forces, Government Departments, Broadcasting Authorities

Racal Communications Limited

Publication No. 7054-1

Programmable synthesized LF/MF/HF communications receiver type RA1779

The Racal RA 1779 meets the increasing demand from both defence and civil organizations for a synthesized programmable receiver capable of operating in Channel Scanning, Surveillance and Band Occupancy Systems whilst retaining the simplicity and use of a manually-operated, free-tune general purpose communications receiver.

Embodying the latest techniques in receiver design, the RA 1779 reflects the company's experience of international professional communications. The superior performance of the RA 1770 series, particularly in dynamic range, intermodulation products and reciprocal mixing, is enhanced by this latest addition to the range.

This advanced equipment is designed for full local operator control and with optional built-in facilities for ISB, FSK and AFC is suitable for all modes of reception within the frequency range 15 kHz to 30 MHz. The RA 1779 has a built-in EAROM memory unit which may be programmed with up to 31 channel frequencies and ensures that programmed frequency information is retained for periods in excess of one year if the receiver is disconnected from the mains supply or removed from service.

Single knob control of the frequency synthesizer is provided with three-speed electronically selected tuning rate. This arrangement allows the receiver to be tuned continuously across its working range with the smoothness and feel of a VFO (favoured by many operators), but with the stability and accuracy associated with frequency synthesis.

The RA 1779 provides all the advantages of full manual operator control plus rapid switching of selected frequencies in regular use. Any of the 31 channels can be re-programmed at any time without specialized test gear or training. A seven digit readout indicates the tuned frequency with a resolution of 10 Hz, but this may be inhibited for security reasons. The key operated switch on the front panel is used for entering new frequencies but also ensures that no programmed channel is inadvertently erased.

Another important feature of this receiver is its ability to be controlled from an extended or remote point, essential in many surveillance applications. The receiver is automatically set for wideband operation when under external control. Control of programmed channels, clarifier and AFC is provided, using the Racal LA 1519/LA 1520 sequential tone remote control system, described later.

The receiver accommodates up to six IF selectivity filters, the quantity and type depending on the user's needs. These may be asymmetrical SSB/ISB with either 3 kHz or 6 kHz nominal bandwidths, conventional AM filters or an AFC carrier filter.

For CW operation a BFO with a range of ± 3 kHz is fitted, a slow motion drive providing extremely smooth control.

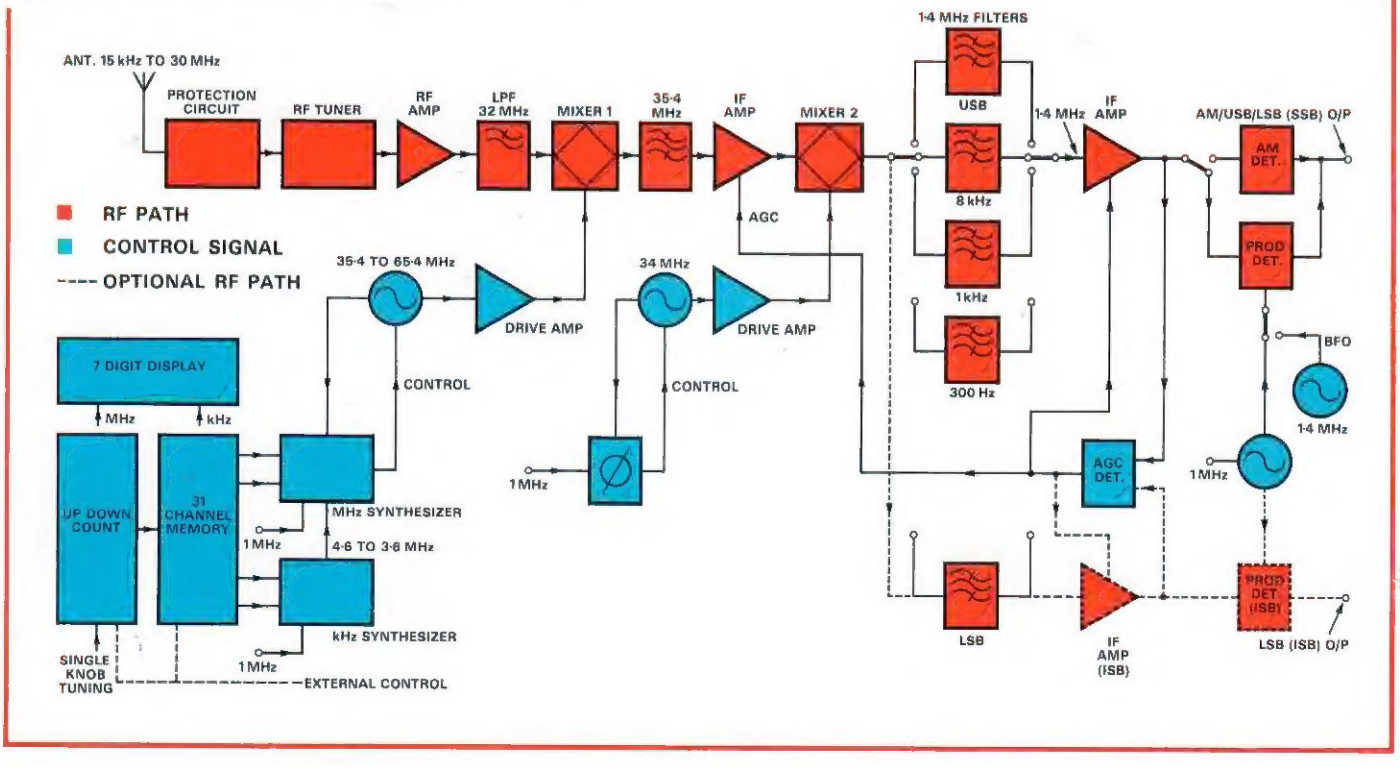
The high stability of the RA 1779 is achieved by a frequency synthesizer referenced to a built-in frequency standard which in the basic model is a temperature-compensated crystal oscillator (TCXO). For applications demanding higher orders of accuracy (better than 2 in 10^7) particularly over wide operating temperature ranges, alternative units such as the Racal 9400 series of frequency standards can be supplied as optional extras. Alternatively the receiver may be locked to any external frequency standard with an output at 1 MHz.

The operating facilities of the receiver are extended further by a number of optional external units. A bandpass filter (2 to 30 MHz) for fitting into the receiver antenna system, a telephony switching unit for speech diversity systems and a 1.4 MHz to 100 kHz IF conversion unit are among the modules available. Comprehensive input and output connectors on the rear panel provide access to the various facilities and options so that the RA 1779 may be used in complex receiver systems. When fitted with the optional FSK module direct connection may be made to 1 or 2 teleprinters without the need for external telegraph power supply units or line protection circuits.

A switched monitor loudspeaker and front panel headphone jack are provided in addition to comprehensive metering facilities for the indication of RF level, AF level, FSK tune and supply voltage levels. The self-contained power supply unit permits operation from 100-125/200-250V AC mains. The mechanical construction used provides a robust receiver capable of operating under extreme environmental conditions. This compact receiver is normally supplied as a standard rack mounting unit, but bench mounting cabinets are available with a choice of the commercial type, a ruggedized marine version and a mobile/transportable model.

Fig. 1

Type RA1779 Block diagram



Principle of Operation

Signal Path

The simplified block diagram (Fig. 1) shows the basic principle of operation of the RF circuits.

The input signal is fed from the antenna via a protection circuit to a manually-operated RF tuner and thence to a linear RF stage. After amplification and low pass filtering it passes to the first mixer where it is combined with a variable frequency output from the synthesizer. This frequency, in the 35.4 to 65.4 MHz range, is selected by the front panel control and is dependent on the frequency of operation. The synthesizer is tuned in 10 Hz, 20 Hz or 1 kHz increments, depending on the tuning rate selected.

The IF output from the first mixer is fed via a 35.4 MHz band pass filter and an IF amplifier to the second mixer, where it is combined with a 34 MHz output from the synthesizer to provide a 1.4 MHz IF output. Dependent upon the mode selected, the 1.4 MHz signal is then fed to the SSB or IF selectivity filters.

The output from the selected filter passes via the main IF amplifier to an AGC amplifier and detector which controls the gain of the various IF amplifier stages, and to the detector stage. A product detector is provided for CW/SSB modes and an envelope detector for AM. For CW a variable BFO is provided whose frequency can be varied ± 3 kHz from the 1.4 MHz IF. For SSB or ISB reception a 1.4 MHz output derived from the frequency standard provides a reinserted carrier.

In the ISB mode two identical IF and AF amplifiers provide separate upper and lower sideband outputs.

Control and Memory Circuits

Fig. 2 shows the principles of operation of the control and memory circuits in simplified form.

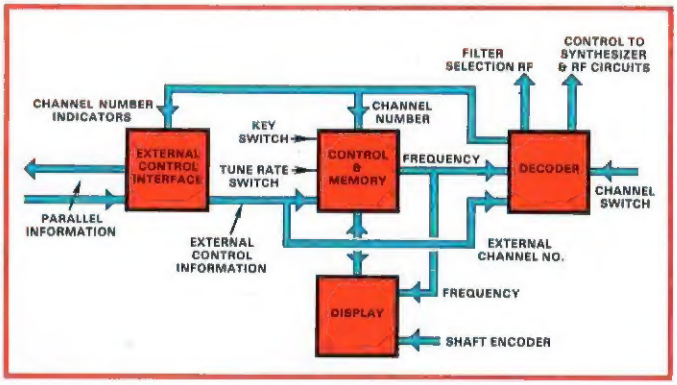


Fig. 2 RA 1779 Control and Memory Circuits, Simplified Block Diagram.

The control and memory circuits of the RA 1779 provide a choice of free-tune or channelized operation selected by the front panel key-switch. In the 'Tune' position, the receiver may be used as a typical manually-controlled model with continuous tuning across the entire frequency band.

Selection of the 'Channel' position on the key-switch sets the receiver for channelized operation and tunes the receiver to the frequency stored in the channel selected by the Channel Switch. This frequency is normally displayed on the readout but may be inhibited by operating an internal switch. In channelized operation, whether the display is on or off, the clarifier control may be used to give a fine tuning range of ± 500 Hz. For specialized operations a third display alternative is available. This provides a frequency readout for channel 0 with full tuning facilities while inhibiting the readout and limiting tuning to the clarifier range for all other channels.

To enter a new frequency or to re-programme an existing channel the key-switch is set to 'Tune' and the operator tunes the receiver to the required frequency using the tuning rate switch and shaft encoder. This frequency is entered into the memory by turning the key-switch to the 'Load' position.

The RA 1779 also provides external control of channel, clarifier and AFC when used with the LA 1519/1520 Remote Control System. In such operation the tuning rate switch is set to 'Ext', connecting the control and memory circuits to the external control inputs. In the external control mode two lines to the clarifier control provide up/down and clock information while a third line removes the limits to the clarifier control to provide a sweep-tune facility.

Extended/Remote Control System LA 1519/1520

Designed for use with any of the current Racal range of channelized receivers, the LA 1519/1520 system may be used for extended or remote control of the RA 1779 and typical system configurations are shown in Figs. 3 and 4.

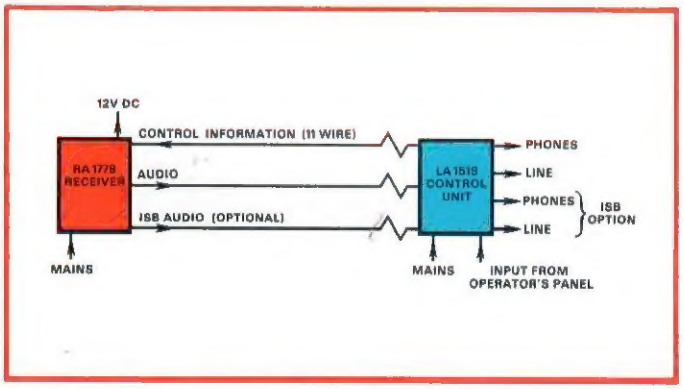


Fig. 3 Extended Control of RA 1779 Receiver.

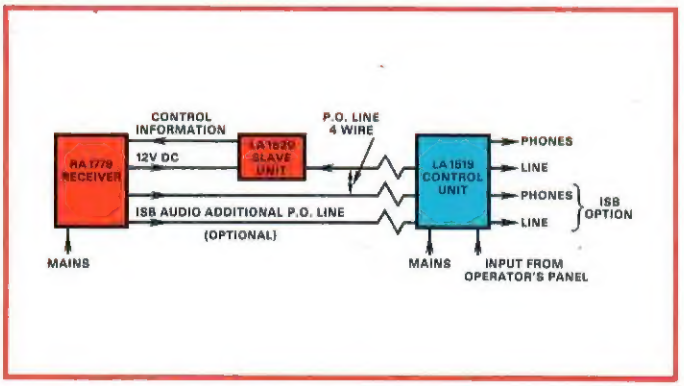


Fig. 4 Remote Control of RA 1779 Receiver.

In extended control, the LA 1519 is connected directly to the receiver to provide control of channel, clarifier and AFC. Audio from the receiver is fed back to the Control Unit. Models are available for SSB or ISB operation.

For remote control, the LA 1519 Control Unit, located at the operating site, generates information in a binary form and converts it to a sequential tone code which is sent over a telephone line or radio link to the receiver site. Here the LA 1520 Slave Unit decodes the tones and provides data in parallel form for the control of receiver functions.

Facilities for monitoring the incoming signal either by built-in loudspeaker or headphones are provided. Two audio pairs only are required for the transfer of data and carriage of traffic with a typical data transfer time of 500 ms.

A full description of the LA 1519/1520 is given in a separate publication available on request.

Channel Scanning, Surveillance and Band Occupancy Applications

The flexibility of the RA 1779 with its ability to be externally controlled makes it the ideal receiver to form the basis of cost-effective surveillance, channel scanning or band occupancy recording systems for use by defence forces, government departments and broadcasting authorities.

A typical Surveillance/Channel Scanning System is shown in Fig. 5 and employs the MA 1107 Automatic Search Unit to control the RA 1779 receiver. This unit allows the receiver frequency to be swept either continuously (10 Hz steps)—SWEEP mode, or in increments over a desired frequency range—SCAN mode, or to be stepped through a given number of channels—LIST mode, monitoring each in turn repetitively.

Operation of all modes is based on the channel selected which defines the start point of the LIST, SWEEP or SCAN. The sweep or scan range from the selected channel is set by the band search control, while in the list mode (Auto) the receiver is stepped up to channel 29 from channel 0 with facilities for inhibiting particular channels. Selection of the required sweep, scan or list speed controls the receiver clock rate in the SWEEP mode or the dwell time between steps in the SCAN or LIST modes. At any time the sweep, scan or list process may be stopped, allowing the manual step controls to increment or decrement the receiver one or more frequency steps or channels in the appropriate direction.

This system may be housed in a ruggedized container for mobile or transportable applications, power for the MA 1107 being derived from the receiver.

For band occupancy recording, the addition of the MA 1109 Band Occupancy Recorder gives a graphic presentation of results. This system is shown in broken lines in Fig. 5.

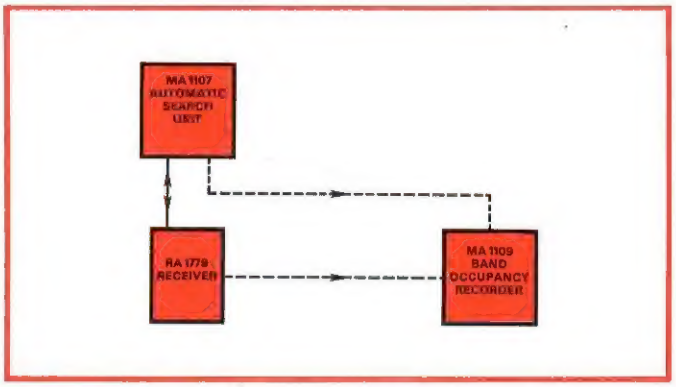
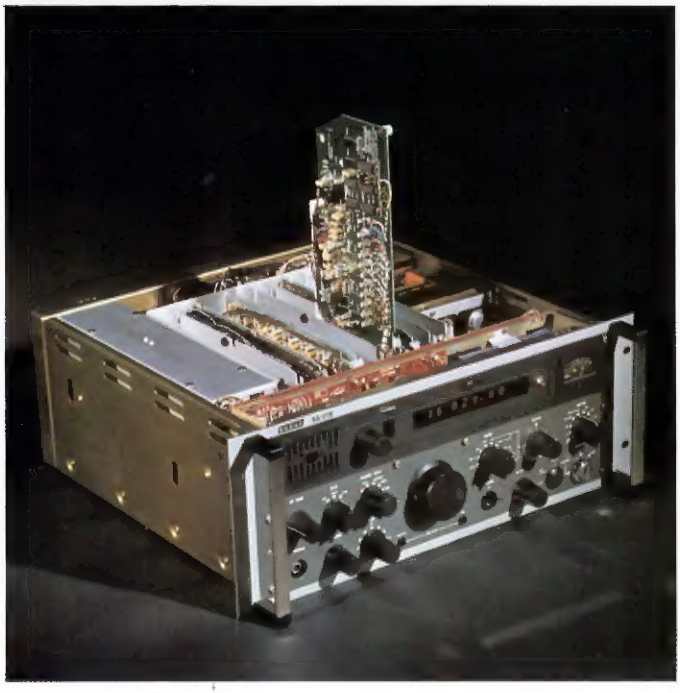


Fig. 5 Surveillance, Channel Scanning and Band Occupancy System.

Full descriptions of the MA 1107 and MA 1109 are given in separate publications available on request.



Ease of accessibility is a feature of the RA 1779 receiver. The circuit boards may be raised into the position shown for test and maintenance purposes.

Rear view of RA 1779 receiver showing connectors and other user facilities.

Technical Specification

Frequency range
15 kHz - 30 MHz.

Modes of reception
A1, A2, A2H, A2J, A3, A3A, A3J, A3H with the following options:
(a) Choice of USB and/or LSB.
(b) Provision for reception of A3B or F1.
(c) Provision for AFC with tuning indicator.

Tuning
(a) 31 Programmable channels.
(b) Continuously tunable synthesizer with choice of fast, medium or slow tuning rates, operating over the full frequency range.
(i) Fast: 1 MHz per turn, 1 kHz increments.
(ii) Medium: 20 kHz per turn, 20 Hz increments.
(iii) Slow: 1 kHz per turn, 10 Hz increments.
(iv) Lock: disconnects the tuning control.
(c) In the channel mode, when the slow tuning rate is selected, the tuning control operates as a clarifier with ± 500 Hz range in 10 Hz increments.
(d) 7-digit frequency display. May be switched on or off by internal switches.

Memory
A 31 channel memory provides frequency storage only. Information is retained for a minimum of 1 year after programming.

Tuning accuracy
± 5 Hz relative to the frequency of the wanted signal.

External control
(a) Channel Selection.
In the external control position, channels are selected from a rear panel socket by using a 5-wire binary code. Revertive information on channel selected is also provided by 5 output lines.
(b) Clarifier.
Clarifier control is obtained by stepping the frequency in 10 Hz steps up to ± 500 Hz in either direction, using an up/down count and a clock line.
(c) Sweep Tune.
By removing the ± 500 Hz limit on the clarifier, the receiver may be swept up or down in steps from any frequency in the operating range.

Frequency stability
(1) The following optional frequency standards may be fitted:
(a) Temperature Controlled Crystal Oscillator (TCXO).
(i) Temperature: better than ± 1.5 in 10^6 from −10°C to +55°C.
(ii) Long Term: ±2 in 10^7 over a 30 day period.
(b) Frequency Standard Type 9442.
(i) Temperature: ± 3 in 10^9/°C.
(ii) Long Term: ± 3 in 10^9 per day after 3 months continuous operation.
(c) Frequency Standard Type 9420.
(i) Temperature: ± 6 in 10^{10}/°C.
(ii) Long Term: ± 1.5 in 10^8 over a 30 day period or ± 5 in 10^{10} per day.
(2) Provision is made for the use of an external 1 MHz frequency standard, 0 dBm into 50 ohms.
(3) An external ± 12 V supply may be connected to maintain the power supply to the frequency standard oven when the normal mains supply is switched off.

Antenna input
(a) 50 ohms to 75 ohms nominal. BNC coaxial connector.
(b) Receiver muting is provided to protect the receiver from local emissions on the tuned frequency. The operation of the muting circuits permits 'break-in' or 'listen-through' operation when keying at a rate of up to 20 bauds.
(c) The receiver will withstand without damage RF input signals of 30 V EMF for a period of 15 minutes. A fuse and spark gap are provided for protection against higher voltages.
(d) Re-radiation with the antenna input terminated in 50 ohms is less than 10 μV.

RF tuning
(a) RF tuning is provided as a standard facility within the receiver. This is achieved by five automatically selected bandpass filters covering the frequency range 1 to 30 MHz with manual RF peak tuning over each pre-selected frequency band. A low-pass filter is used below 1 MHz.
(b) Each tuned range provides 20 dB attenuation at 12½% off-tune.
(c) Wideband operation is automatically selected when the receiver is switched to extended or remote control.

Sensitivity
(a) CW and SSB (A1, A2H, A3A, A3H, A3J).
In a 3 kHz bandwidth the signal-to-noise ratio is better than:
15 kHz - 50 kHz, 15 dB with 10 μV (EMF) input.
50 kHz - 500 kHz, 15 dB with 3 μV (EMF) input.
500 kHz - 30 MHz, 15 dB with 1 μV (EMF) input.
(b) DSB (A2, A3).
In a 3 kHz bandwidth the signal-to-noise ratio is better than:
15 kHz - 50 kHz, 15 dB with 15 μV (EMF) input 70% modulated.
50 kHz - 500 kHz, 15 dB with 5 μV (EMF) input 70% modulated.
500 kHz - 30 MHz, 15 dB with 1.5 μV (EMF) input 70% modulated.

IF selectivity
(a) SSB and ISB (A3A, A3J, A3B).
Passband at −6 dB: 250 Hz to 3000 Hz.
Passband at −60 dB: −400 Hz and +4100 Hz.
Or alternatively:
Passband at −6 dB: 250 Hz to 6000 Hz.
Passband at −60 dB: −300 Hz and +8000 Hz.
(b) CW/MCW/AM/FSK (A1, A2, A3, A2H, A3H, F1).
Standard receivers. In addition to the mode-selected SSB or ISB filters, up to four optional IF filters may be fitted although certain combinations of facilities will permit only three filters to be fitted. IF filters of the following nominal passbands are available; 0.3 kHz, 1 kHz, 3 kHz, 6 kHz, 8 kHz, 13 kHz. Alternative filters can be supplied to special order.

Cross modulation
With a wanted signal greater than 300 μV EMF, in a 2 kHz bandwidth, an unwanted signal, 30% modulated, removed not less than 20 kHz, will be greater than 300 mV EMF to produce an output 20 dB below the output produced by the wanted signal.

Reciprocal mixing
With a wanted signal of less than 100 μV EMF in a 2 kHz bandwidth, an unwanted signal more than 20 kHz removed will be greater than 70 dB above the wanted signal level to give a noise level 20 dB below the output produced by the wanted signal.

Blocking
With a wanted signal of 1 mV EMF, an unwanted signal more than 20 kHz removed must be greater than 500 mV EMF to reduce the output by 3 dB.

Intermodulation products
(a) In Band.
Two equal tones with levels up to 30 mV EMF within the IF passband will produce third order intermodulation products at least 40 dB below the level of either tone.
(b) Out of Band.
With two 30 mV EMF signals separated and removed from the wanted signal by not less than 20 kHz, the third order intermodulation products are not less than −85 dB below either of the interfering signals, and typically better than −90 dB.

Spurious responses
(a) External.
External signals, 20 kHz removed from the wanted signal, must be at least 80 dB above the level of the wanted signal to produce an equivalent output.
(b) Internal.
The specified sensitivity figures in the CW/SSB modes are not reduced by more than 3 dB as a result of any internally generated spurious signals.

AGC
(a) Range.
An increase in input of 100 dB above 2 μV EMF will produce an output change of less than 6 dB.
(b) Time Constants.
Switched selection of AGC 'off,' 'short' and 'long' time constants.

	Charge	*Discharge*
Short	4 ms to 40 ms	200 ms to 500 ms
Long	30 ms to 120 ms	4 s to 7 s

AFC (A3A, A3B)
(a) AFC is available as an optional internal facility and is provided with a front panel switch for switching AFC in or out of operation.
(b) Capture range: ± 50 Hz.
Follow range: ± 500 Hz or beyond.
Residual error: 2 Hz max.
Memory: in the event of carrier failure, or worsening of the carrier to noise/modulation level of 10 dB, no retuning is necessary for fades of up to 1 minute.

BFO range
± 3 kHz variable by a slow motion control.

IF output (AGC on)
1.4 MHz, nominally 100 mV EMF into 50 ohms.

Audio characteristics
(a) Output levels:
(i) Line outputs, 1 mW nominal into 600 ohms balanced, adjustable by preset level control on front panel over ± 6 dB.
(ii) Phone outputs unbalanced, 10 mW nominal into 600 ohms.
(iii) 50 mW into an internal loudspeaker which is capable of being switched in or out of operation.
(iv) Connection for external speaker, 1 W into 8 ohms.
(b) AF response:
(i) Line outputs. Within 1 dB from 100 Hz to 6000 Hz relative to the level of a standard 1000 Hz tone.
(ii) The overall AF response is dependent upon the IF bandwidth selected.
(c) AF distortion:
(i) Line outputs. Not greater than 2% at specified output of 1 mW nominal.
(ii) Loudspeaker outputs. Not greater than 5% at 50 mW output to internal loudspeaker and 1 W output to external speaker.
(iii) Phone outputs. Not greater than 5% at specified output of 10 mW nominal.

Unwanted sideband rejection
At least 60 dB at −500 Hz USB mode, or +500 Hz LSB mode, relative to carrier frequency.

Cross talk (A3B)
With a wanted signal at a level of 1 mV and the AF output adjusted to 1 mW, the crosstalk from an equal signal in the opposite sideband, at greater than 400 Hz from the carrier, is not greater than −50 dB relative to 1 mW.

Frequency shift demodulation (optional)
(a) Frequency shift range 85 Hz to 850 Hz.
(b) Maximum keying speed 200 bauds.
(c) Telegraph distortion not greater than 5% up to 100 bauds.
(d) Telegraph output. Polar (double current) DC output approximately 100 mA with choice of 6-0-6 V or 80-0-80 V. Normally positive on 'mark.' Provision is made by internal adjustment for neutral (single current) operation.
(e) Mark/space reversal is available to the operator and a 'tune' switch position is provided to permit tuning of the receiver without operating the teleprinter.

Metering
A meter is provided on the front panel to indicate RF level, AF level to line, FSK tune, and suitable performance or supply test levels.

Power supply
100 V-125 V or 200 V-250 V, ± 10%, 45-65 Hz.

Power consumption
Basic receiver 60 VA nominal.
Fully equipped 90 VA nominal.

Environmental conditions
The equipment is designed to meet the relevant classes of British Defence Specification DEF 133, L2, under the following conditions:
Operating temperature −10°C to +55°C.
Storage temperature −40°C to +70°C.
Relative humidity 95% at 40°C.

Dimensions
(a) Rack Mounted.
Height: 178 mm (7 in).
Width: 483 mm (19 in).
Depth: 410 mm (16.15 in)
(b) In Bench Cabinet.
Height: 220 mm (8.65 in).
Width: 495 mm (19.5 in).
Depth: 445 mm (17.5 in).

Weight (approx)
(a) Rack Mounted
20.4 kg (45 lb).
(b) In Bench Cabinet
26.4 kg (58 lb).

Accessories

AA 660/A
Headset, 600 ohms, with ventilated ear cushions, lead and plug.
Headsets are also available with standard ear cushions and anti-perspiration covers.

BA 45520
Bench Mounting Cabinet.

DA 47020
Ruggedized Bench Mounting Cabinet for marine applications.

DA 46531
Ruggedized Bench Mounting Cabinet fitted with shock mounts for mobile/transportable applications.

Optional external modules

MM 530/1
Bandpass filter, 2-30 MHz, for use in receiver antenna systems.

MM 532/1 and MM 532/2
Telephone Diversity Switching Units for SSB and ISB operation respectively. For use in speech diversity systems.

MS 561/1 and MS 561/2
IF Conversion Modules, 1.4 MHz to 100 kHz for SSB and ISB operation respectively. Provide 100 kHz output(s) for use with ancillary equipment.

Note:

All accessories and optional facilities and modules to be specified at time of order.

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